

Modification in Structural and Optical Properties of Erbium-doped Zinc Sodium Tellurite Glass: Effect of Bimetallic Nanoparticles

ABSTRACT

The demand in accomplishing modified structural and optical features of trivalent rare earth (RE) ions doped amorphous media through the incorporation of metallic nanoparticles (NPs) of controlled sizes is ever-increasing for short wavelength solid state lasers development. In this view, we attempt to alter the optical properties of bimetallic NPs and erbium (Er^{3+}) integrated zinc-sodium-tellurite glass. Modifications in structural properties are triggered via precise control of titanium and copper NPs nucleation and growth processes underneath the amorphous matrix. The changes in ligand interactions in the fragile disordered matrix are found to be accountable for the variations in structural and optical properties. A series of glass with composition of $(70-x-y)\text{TeO}_2-20\text{ZnO}-9\text{Na}_2\text{O}-1\text{Er}_2\text{O}_3-(x)\text{CuO}-(y)\text{TiO}_2$ ($x = 0.0$ and 0.04 mol%; $y = 0.0$ and 0.1 mol%) are prepared following melt-quenching method and characterized. UV-Vis-NIR spectra displayed seven absorption bands corresponding to the transitions from ground state ($4\text{I}_{15/2}$) to $4\text{F}_{5/2}$, $4\text{F}_{7/2}$, $2\text{H}_{11/2}$, $4\text{S}_{3/2}$, $4\text{F}_{9/2}$, $4\text{I}_{9/2}$ and $4\text{I}_{11/2}$ excited states of Er^{3+} . FTIR spectra show the presence of symmetric Te-O-Te linkage vibrations and stretching vibrations of Cu-O on monoclinic CuO, Te-O bond of the trigonal bipyramidal unit $[\text{TeO}_4]$ with non-bridging oxygen symmetrical TeO_3 groups and vibrations of water molecule. The presence of bimetallic NPs is confirmed from transmission electron microscopy (TEM) imaging. Our glass composition demonstrating such significant modification in structural and optical properties may be beneficial for the development of plasmonic devices.